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February 11, 2002

BOX PCT
Commissioner for Patents
Washington, D.C. 20231

PCT/SG00/00114
-filed August 7, 2000

Re: Application of Wei Yun YAU, Xudong JIANG and Wee SER
FINGERPRINT SENSING APPARATUS
Assignee: NANYANG TECHNOLOGICAL UNIVERSITY
Our Ref: Q68490

Dear Sir:

The following documents and fees are submitted herewith in connection with the above application for the purpose of entering the National stage under 35 U.S.C. § 371 and in accordance with Chapter II of the Patent Cooperation Treaty:

☑ a Preliminary Amendment

The Declaration and Power of Attorney and Assignment will be submitted at a later date.

It is assumed that copies of the International Application, the International Search Report, the International Preliminary Examination Report, and any Articles 19 and 34 amendments as required by § 371(c) will be supplied directly by the International Bureau, but if further copies are needed, the undersigned can easily provide them upon request.

The Government filing fee is calculated as follows:

Total claims	19	-	20	=	_____	x	$18.00	= $.00
Independent claims	1	-	3	=	_____	x	$84.00	= $.00
Base Fee								$890.00
TOTAL FEE								$890.00

A check for the statutory filing fee of $890.00 is attached. You are also directed and authorized to charge or credit any difference or overpayment to Deposit Account No. 19-4880. The Commissioner is hereby authorized to charge any fees under 37 C.F.R. §§ 1.16, 1.17 and 1.492 which may be required during the entire pendency of the application to Deposit Account No. 19-4880. A duplicate copy of this transmittal letter is attached.

Priority is claimed from:

Country	Application No	Filing Date
Singapore	PCT/SG99/00082	August 10, 1999

Respectfully submitted,

Alan J. Kasper
Registration No. 25,426

AJK/slb

PATENT APPLICATION

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re application of

Wei Yun YAU, et al.

Appln. No.: NOT YET ASSIGNED

Confirmation No.: NOT YET ASSIGNED

Group Art Unit: NOT YET ASSIGNED

Filed: February 11, 2002

Examiner: NOT YET ASSIGNED

For: FINGERPRINT SENSING APPARATUS

PRELIMINARY AMENDMENT

Commissioner for Patents
Washington, D.C. 20231

Sir:

Prior to examination, please amend the above-identified application as follows:

IN THE CLAIMS:

Please enter the following amended claims:

3. Apparatus according to claim 1, wherein the devices are arranged so that the sensing array surfaces form a one dimensional array.

4. Apparatus according to claim 1, wherein the devices are arranged so that the sensing array surfaces form a two dimensional array.

5. Apparatus according to claim 1, wherein the sensing array surfaces are less than 15mm x 15mm.

7. Apparatus according to claim 1, further comprising a ground contact located between the sensing array surfaces of at least two adjacent devices.

9. Apparatus according to claim 7, wherein the ground contact is in the form of a grid.

10. Apparatus according to claim 7, wherein the ground contact has a conducting surface which is raised above the surface of the sensing array surfaces.

11. A method f constructing a fingerprint image, the method comprising obtaining a number of fingerprint image portions from a finger of a user using fingerprint sensing apparatus according to claim 1, each image portion being obtained from a corresponding semiconductor device, calculating direction information at an edge of a first image portion corresponding to an edge of a first sensing array surface which is adjacent to but separated from an edge of a second sensing array surface, interpolating the direction information and pixel values at the edge of the first image portion to obtain the values of pixels between the edge of the first image portion and an edge of a second image portion corresponding to the edge of the second sensing array surface.

13. A method of constructing a fingerprint image, the method comprising obtaining a first set of fingerprint image portions from a finger of a user using fingerprint sensing apparatus according to claim 1, each image portion being obtained from a corresponding semiconductor device, obtaining a second set of fingerprint image portions from the fingerprint sensing apparatus with the position of the finger on the sensing apparatus offset from the position in which the first set of image portions was obtained, and comparing the first and the second sets of fingerprint image portions.

Please enter the following new claims:

14. Apparatus according to claim 2, wherein the devices are arranged so that the sensing array surfaces form a one dimensional array.

15. Apparatus according claim 2, wherein the devices are arranged so that the sensing array surfaces form a two-dimensional array.

16. Apparatus according claim 8 wherein the ground contact is in the form of a grid.

17. Apparatus according to claim 8 wherein the ground contact has a conducting surface which is raised above the surface of the sensing array surfaces.

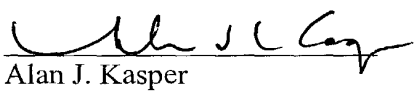
18. Apparatus according to claim 9, wherein the ground contact has a conducting surface which is raised above the surface of the sensing array surfaces.

19. Apparatus according to claim 16, wherein the ground contact has a conducting surface which is raised above the surface of the sensing array surfaces.

REMARKS

Entry and consideration of this Amendment is respectfully requested.

Respectfully submitted,



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Date: February 11, 2002

APPENDIX

VERSION WITH MARKINGS TO SHOW CHANGES MADE

IN THE CLAIMS:

The claims are amended as follows:

3. Apparatus according to claim 1 ~~or claim 2~~, wherein the devices are arranged so that the sensing array surfaces form a one dimensional array.

4. Apparatus according to claim 1 ~~or claim 2~~, wherein the devices are arranged so that the sensing array surfaces form a two dimensional array.

5. Apparatus according to ~~any of the preceding~~ claims 1, wherein the sensing array surfaces are less than 15mm x 15mm.

7. Apparatus according to ~~any of the preceding~~ claims 1, further comprising a ground contact located between the sensing array surfaces of at least two adjacent devices.

9. Apparatus according to claim 7 ~~or claim 8~~, wherein the ground contact is in the form of a grid.

10. Apparatus according to ~~any of~~ claims 7 ~~to 9~~, wherein the ground contact has a conducting surface which is raised above the surface of the sensing array surfaces.

11. A method f constructing a fingerprint image, the method comprising obtaining a number of fingerprint image portions from a finger of a user using fingerprint sensing apparatus according to ~~any of~~ claims 1 ~~to 10~~, each image portion being obtained from a corresponding semiconductor device, calculating direction information at an edge of a first image portion corresponding to an edge of a first sensing array surface which is adjacent to but separated from an edge of a second sensing array surface, interpolating the direction information and pixel

values at the edge of the first image portion to obtain the values of pixels between the edge of the first image portion and an edge of a second image portion corresponding to the edge of the second sensing array surface.

13. A method of constructing a fingerprint image, the method comprising obtaining a first set of fingerprint image portions from a finger of a user using fingerprint sensing apparatus according to ~~any of~~ claims ~~1 to 10~~, each image portion being obtained from a corresponding semiconductor device, obtaining a second set of fingerprint image portions from the fingerprint sensing apparatus with the position of the finger on the sensing apparatus offset from the position in which the first set of image portions was obtained, and comparing the first and the second sets of fingerprint image portions.

Fingerprint Sensing Apparatus

The invention relates to fingerprint sensing apparatus, and especially, solid state fingerprint sensing apparatus.

Solid state fingerprint sensors are produced on a single semiconductor chip (or die) and comprise an array of sensing elements, such as capacitive sensors or electric field sensors, formed in a two dimensional array on the surface of the die.

However, this fabrication technique has the disadvantage that the die must have a surface area which is at least the same size as the fingerprint sensing area. As, the fingerprint sensing area must be large enough to accommodate the fingerprint of a user, the fingerprint sensing area must generally be at least 10mm x 10mm. If the fingerprint sensing area is much smaller than this then the area will be too small to permit the fingerprint of a user to be captured. Preferably, the fingerprint sensing area should be a larger size.

This creates a problem with die fabrication as the larger the die is the higher the probability that the die will have an error or fault. Therefore, as the die size increases, the probability of having a die in a batch with an error increases and therefore the yield of operable dies from a batch decreases. For this reason, the larger a fingerprint sensor is, the more expensive it is and the increase in cost is driven not only by the increase size, and therefore the increase in material in the die, but also the lower yield from a batch.

In addition, the requirement for larger dies also reduces the efficiency with which the silicon wafer surface area can be utilised as less dies can be fitted on the surface of the wafer. This also has the disadvantage of increasing the cost of solid state fingerprint sensors.

US Patent Nos. 5,907,627 and 5,778,089 attempt to overcome these problems by providing a number of dies in a single packaged device.

In accordance with a first aspect of the present invention, fingerprint sensing apparatus comprises a number of packaged semiconductor devices, each packaged semiconductor device comprising a single fingerprint sensor die, each die comprising a sensing array surface, and the packaged semiconductor devices being arranged so that the sensing array surfaces of the dies define an apparatus sensing surface.

An advantage of the invention is that as the fingerprint sensing apparatus is formed from a number of packaged semiconductor devices, each device comprising a single fingerprint sensor die, the sensing area of the fingerprint sensing apparatus is not restricted to the surface area of one die on which a fingerprint sensor array is formed as the size of the apparatus sensing surface can be increased or decreased by using an appropriate number of fingerprint sensor dies. Therefore, fingerprint sensor dies with a relatively small sensing array surface can be used to form a fingerprint sensing apparatus with a relatively large apparatus sensing surface. In addition, the fingerprint sensing apparatus of the

invention also has the advantage that the size of the area of the apparatus sensing surface can be configured relatively easily by increasing or decreasing the number of semiconductor devices.

Typically, the apparatus sensing surface is substantially planar.

In one example of the invention, the sensing array surfaces may be arranged in a one dimensional array. This arrangement is particularly useful where the length of the sensing array surface of each die is relatively large compared with the width.

Alternatively, the semiconductor devices may be arranged so that the sensing array surfaces form a two dimensional array. This arrangement is particularly useful where the width and length of the sensing array surfaces are of a similar size.

Preferably, each sensing array surface is less than 15mm x 15mm and more preferably, less than 10mm x 10mm.

Typically, the fingerprint sensing apparatus may further comprise a ground contact located between the sensing array surfaces of two adjacent semiconductor devices. Preferably, the ground contact may be located between each pair of adjacent sensing array surfaces.

In one example of the invention, the ground contact may be in the form of a grid

with a conducting surface which is raised above the surface of the sensing array surfaces. This has the advantage that when a user places a finger on the apparatus sensing surface, the risk of the fingerprint touching a sensing surface before touching the grid is minimised so that any static charge on the user is discharged through the ground contact and not onto one of the sensing array surfaces. This has the advantage of minimising the possibility of a user carrying a static charge damaging the apparatus device by a static discharge onto one or more of the sensing array surfaces.

In accordance with a second aspect of the present invention, there is provided a method of constructing a fingerprint image, the method comprising obtaining a number of fingerprint image portions from a finger of a user using fingerprint sensing apparatus in accordance with the first aspect of the invention, each image portion being obtained from a corresponding semiconductor device, calculating direction information at an edge of a first image portion corresponding to an edge of a first sensing array surface which is adjacent to but separated from an edge of a second sensing array surface, interpolating the direction information and pixel values at the edge of the first image portion to obtain the values of pixels between the edge of the first image portion and an edge of a second image portion corresponding to the edge of the second sensing array surface.

Preferably, the method further comprises calculating direction information at the edge of the second image portion and interpolating the direction information and the pixel values at the edges of the first and second image portions to obtain the

values of pixels between the edges of the first and second image portions.

In accordance with a third aspect of the present invention, there is provided a method of constructing a fingerprint image, the method comprising obtaining a first set of fingerprint image portions from a finger of a user using a fingerprint sensing apparatus according to the first aspect of the invention, each image portion being obtained from a corresponding semiconductor device, obtaining a second set of fingerprint image portions from the fingerprint sensing apparatus with the position of the finger on the sensing apparatus offset from the position in which the first set of image portions was obtained, and comparing the first and the second sets of fingerprint image portions.

An example of fingerprint sensing apparatus in accordance with the invention will now be described with reference to the accompanying drawings, in which:-

Figure 1 shows a plan view of an apparatus sensing surface of fingerprint sensing apparatus with semiconductor devices comprising a single fingerprint sensor die arranged in a one dimensional array;

Figure 2 is a plan view of an apparatus sensing surface of a fingerprint sensing apparatus with semiconductor devices comprising a single fingerprint sensor die arranged in a two dimensional array;

Figure 3 is a perspective exploded view of a first example of fingerprint sensing apparatus having a two dimensional array;

Figure 4 is a perspective exploded view of a second example of fingerprint sensing apparatus having a two dimensional array;

Figure 5 is a cross-sectional view of the fingerprint sensing apparatus shown in Figure 3 or 4; and

Figure 6 shows a portion of two fingerprint image portions obtained using the apparatus shown in Figures 1 to 5;

Figure 1 shows fingerprint sensing apparatus 10 which comprises four individual packaged semiconductor devices 11 each having a single fingerprint sensor die. The devices 11 are arranged in a one dimensional linear array. Each of the fingerprint sensor dies has a sensing array surface 12. Each of the fingerprint sensor dies is a conventional solid-state fingerprint sensor, such as a direct contact, fingerprint acquisition device using capacitive sensing. This type of device has an array of solid-state capacitors formed on surface 12. An example of a commercially available, solid state device 11 that could be used in the fingerprint sensing apparatus 10 is a Veridicom FPS100 produced by Veridicom, Inc. of Santa Clara, California, USA.

Each of the devices 11 has an individual controller (not shown) and all the individual controllers are multiplexed to a main central sensor controller (not shown) for the fingerprint sensing apparatus 10. The central sensor controller may also include a sensor oscillator (not shown) which can be used to ensure synchronisation of the devices 11.

As an alternative to the devices 11 comprising an array of capacitive sensors, it is possible that they could comprise an array of electric field sensors, or an array of any other suitable type of sensors.

The sensing apparatus 10 also includes a metal grid plate 14 which has four apertures 13 into which the devices 11 locate. The top surface of the grid plate 14 is raised above the sensing array surfaces 12 of the devices 11 and the plate 14 is electrically coupled to a ground contact (not shown).

Therefore, each of the sensing areas 12 together form a device sensing surface for the apparatus 10. The area of the apparatus sensing surface is the sum of the surface areas of each individual sensing array surface 12.

Figure 2 shows another fingerprint sensing apparatus 20 which includes a metallic grid plate 21 with eight apertures 22 therein. A packaged semiconductor device 23 having a sensing array surface 24 is located in each aperture 22 so that the sensor array surfaces 24 together form a device sensing surface for the apparatus 20. Therefore, the sensing surface for the apparatus 20 is eight times the size of each sensing array surface 24.

As shown in Figure 2, the sensor array surfaces 24 are arranged in a two dimensional array. As with the devices 11, described above and shown in Figure 1, the devices 23 may be any conventional solid state fingerprint sensor using a capacitive sensing array, an electric field sensing array or any other suitable type

of sensing array.

As with the metallic grid plate 12, the metallic grid plate 21 is also electrically coupled to ground and the top surfaces of the grid plate 21 are raised above the surface areas 24.

In use, when a user, who is to have their fingerprint captured by the apparatus 10 or the apparatus 20, places their finger on the sensing surface, due to the presence of the metallic grid plate 14, 21, and that the surface of the grid plate 14, 21 is raised above the surface of the sensing array surfaces 12, 24, the user's finger should contact the grid plate 14, 21 before contacting the surface array surfaces 12, 24 so that any static charge on the user will be discharged through the ground plate 14, 21 rather than through one of the devices 11, 23. Therefore, this feature minimises the risk of the devices 11, 23 being damaged by a static discharge during use.

In the two examples described above, the ground plates 14, 21 are formed so that the respective devices 11, 23 fit into the respective apertures 13, 22 by being inserted from below the ground plate 14, 21. This is illustrated schematically for a two dimensional array in Figure 3 where an exploded view of a fingerprint sensing device 47 is shown. The device 47 comprises a 2 x 2 array of devices 23 which are mounted on a printed circuit board (pcb) 41 which has a number of conductive contact pads 42, and a cable 40. The cable 40 is coupled to the contact pads 42

by conductive paths 44 formed on the pcb 41. The pcb 41 is located in a holder 45 which includes a base plate 46 which supports the pcb 41. The devices 23 are mounted on the pcb 41 such that the contact pads 42 contact pads 48 on the underside of the devices 23 as shown in Figure 5. The ground plate 21 is then placed over the pcb 41 such that the devices 23 are located in the apertures 22, as shown in Figure 5.

In an alternative example, it is possible that the ground contacts 21 could be formed on the pcb 41 so that when the devices 23 are mounted onto the pcb 41, the ground contacts extend up between each individual device 23 so that the upper surfaces of the ground contacts 21 are raised above the surfaces of the sensing array surfaces 24. An exploded view of this arrangement is shown in Figure 4, where parts similar to parts in Figure 3 have the same reference numeral.

In use, the various images acquired from each of the individual devices 11, 23 have to be assembled together in order to construct a complete fingerprint image. However, there are gaps 15 between adjacent devices 11 and gaps 25, 26 between adjacent devices 23 corresponding to the ground plates 14, 21. Therefore, if the images from each device 11, 23 are assembled to construct the fingerprint image, there will be discontinuities or gaps 31 (see Figure 6) in the image corresponding to the gaps 15, 25, 26. The discontinuities will cause errors in the minutiae extraction process. Therefore, it is necessary to calculate pixel values 34 for the gaps 15, 25, 26 to ensure that there are no discontinuities in the

final fingerprint image. Two possible ways of filling in the missing information are:

(i) Any fingerprint image is inherently directional. Therefore, direction information 33 is useful in the construction (see Figure 6). The direction information 33 can be computed easily, using various conventional image processing methods. The size of the gap 31 and the resolution of the devices 11, 23 are known in advance from the specification of the devices 11, 23. From the specification, the number of picture elements (pixels) in the image to be allocated for the gap 31 can be calculated. However, the actual values of the pixels 34 in the gap 31 are not known. Therefore, the pixel values 34 can be estimated by using the pixel values 32 and the direction information 33 at both edges of the gap 31 by means of interpolation;

(ii) Alternatively, the fingerprint image can be acquired twice with one of the images being slightly translated from the other in both the horizontal and vertical directions. The unknown pixel values in the separation region 31 can then be estimated from the two images using conventional image processing techniques.

Advantages of the invention are that by forming fingerprint sensing apparatus 10, 20 from a number of packaged semiconductor devices 11, 23 each having a single die, it is possible to form fingerprint sensing apparatus 10, 20 with an apparatus sensing surface which is many times larger than the sensing array

surface 12, 24 of each individual device 11, 23. This has the advantage that relatively small, and therefore inexpensive, devices 11, 23 can be used to form the sensing apparatus 10, 20 with a much larger sensing surface. In addition, by using a number of devices 11, 23 to form the sensing apparatus 10, 20 it is also possible to provide an electrical ground contact grid over the device sensing surface to minimise the risk of static discharge damaging the devices 11, 23 in use.

CLAIMS

1. Fingerprint sensing apparatus comprising a number of packaged semiconductor devices, each packaged semiconductor device comprising a single fingerprint sensor die, each die comprising a sensing array surface, and the packaged semiconductor devices being arranged so that the sensing array surfaces of the dies define an apparatus sensing surface.

2. Apparatus according to claim 1, wherein the apparatus sensing surface is substantially planar.

3. Apparatus according to claim 1 or claim 2, wherein the devices are arranged so that the sensing array surfaces form a one dimensional array.

4. Apparatus according to claim 1 or claim 2, wherein the devices are arranged so that the sensing array surfaces form a two dimensional array.

5. Apparatus according to any of the preceding claims, wherein the sensing array surfaces are less than 15mm x 15mm.

6. Apparatus according to claim 5, wherein the sensing array surfaces are less than 10mm x 10mm.

7. Apparatus according to any of the preceding claims, further comprising a

ground contact located between the sensing array surfaces of at least two adjacent devices.

8. Apparatus according to claim 7, wherein a ground contact is located between each pair of adjacent sensing array surfaces.

9. Apparatus according to claim 7 or claim 8, wherein the ground contact is in the form of a grid.

10. Apparatus according to any of claims 7 to 9, wherein the ground contact has a conducting surface which is raised above the surface of the sensing array surfaces.

11. A method of constructing a fingerprint image, the method comprising obtaining a number of fingerprint image portions from a finger of a user using fingerprint sensing apparatus according to any of claims 1 to 10, each image portion being obtained from a corresponding semiconductor device, calculating direction information at an edge of a first image portion corresponding to an edge of a first sensing array surface which is adjacent to but separated from an edge of a second sensing array surface, interpolating the direction information and pixel values at the edge of the first image portion to obtain the values of pixels between the edge of the first image portion and an edge of a second image portion corresponding to the edge of the second sensing array surface.

12. A method according to claim 11, further comprising calculating direction information at the edge of the second image portion and interpolating the direction information and the pixel values at the edges of the first and second image portions to obtain the values of pixels between the edges of the first and second image portions.

13. A method of constructing a fingerprint image, the method comprising obtaining a first set of fingerprint image portions from a finger of a user using fingerprint sensing apparatus according to any of claims 1 to 10, each image portion being obtained from a corresponding semiconductor device, obtaining a second set of fingerprint image portions from the fingerprint sensing apparatus with the position of the finger on the sensing apparatus offset from the position in which the first set of image portions was obtained, and comparing the first and the second sets of fingerprint image portions.

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(71) Applicant *(for all designated States except US)*: NANYANG TECHNOLOGICAL UNIVERSITY [SG/SG]; Centre for Signal Processing, Nanyang Technological University, EEE, S2-B4b-05, 50 Nanyang Avenue, Singapore 639798 (SG).

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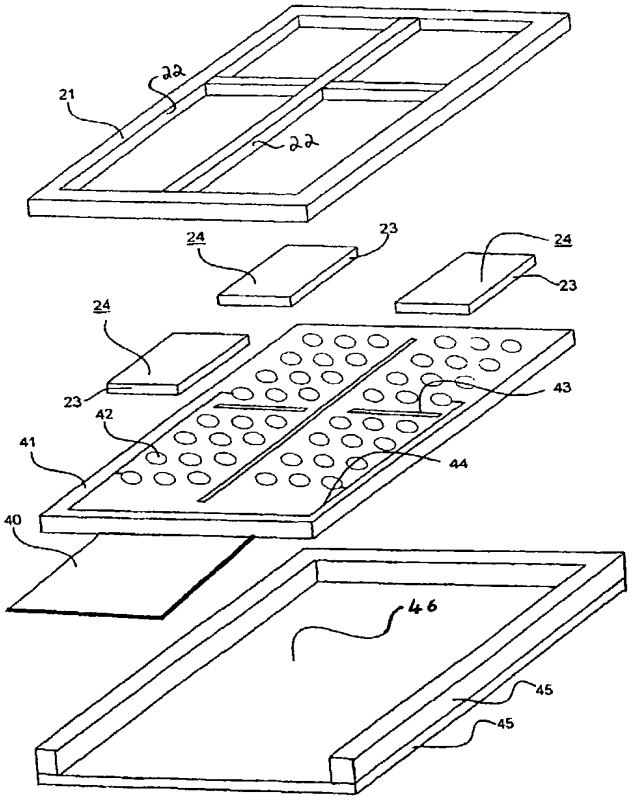
(81) Designated States *(national)*: AE, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CR, CU, CZ, DE, DK, DM, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ,

[Continued on next page]

(54) Title: FINGERPRINT SENSING APPARATUS



(57) Abstract: Fingerprint sensing apparatus (10) includes a number of packaged semiconductor devices (11), each packaged semiconductor device (11) comprising a single fingerprint sensor die. Each die includes a sensing array surface (12). The devices (11) are arranged so that the sensing array surfaces (12) of the devices (11) define an apparatus sensing surface.

WO 01/11543 A1

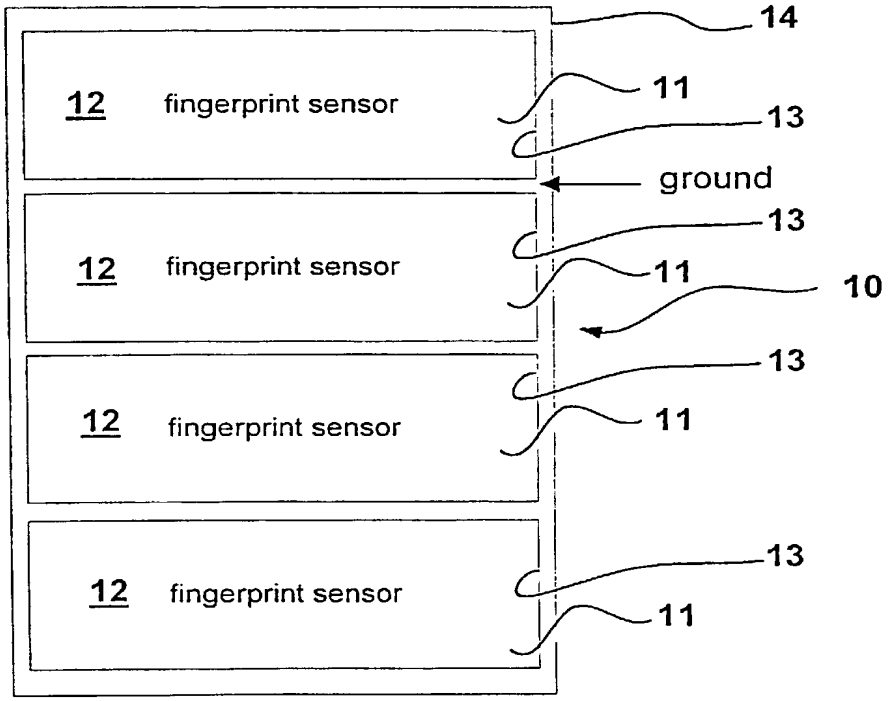


Figure 1

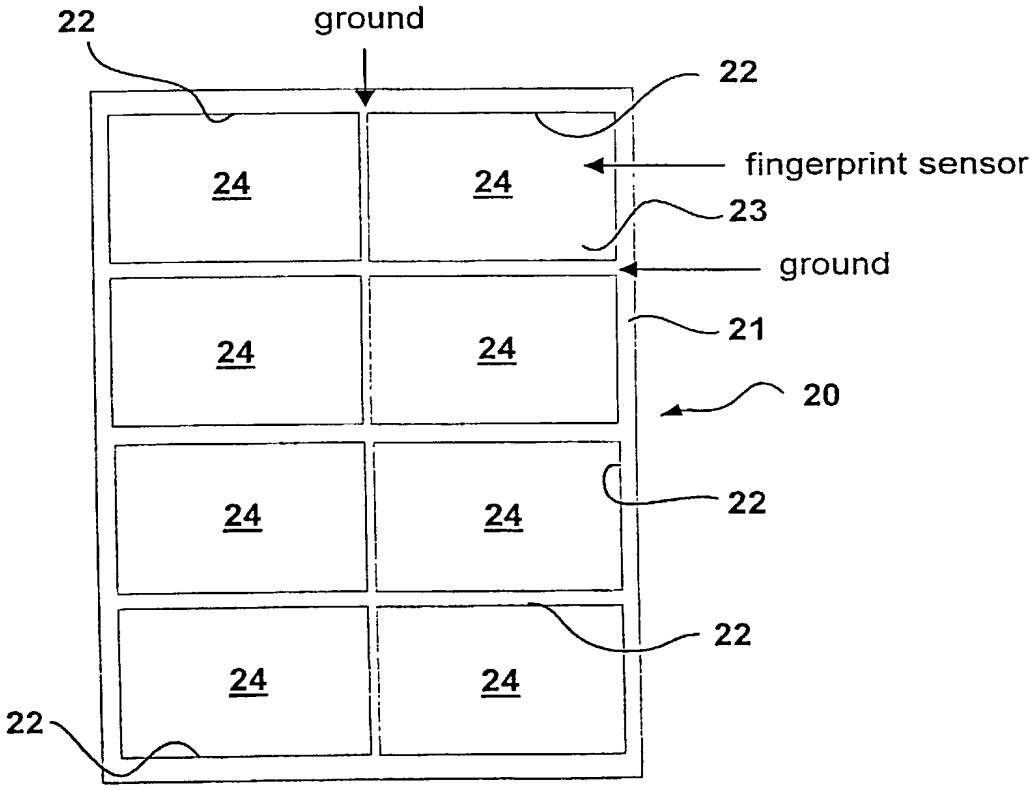


Figure 2

Fingerprint sensor array formed from a subset of smaller fingerprint sensors

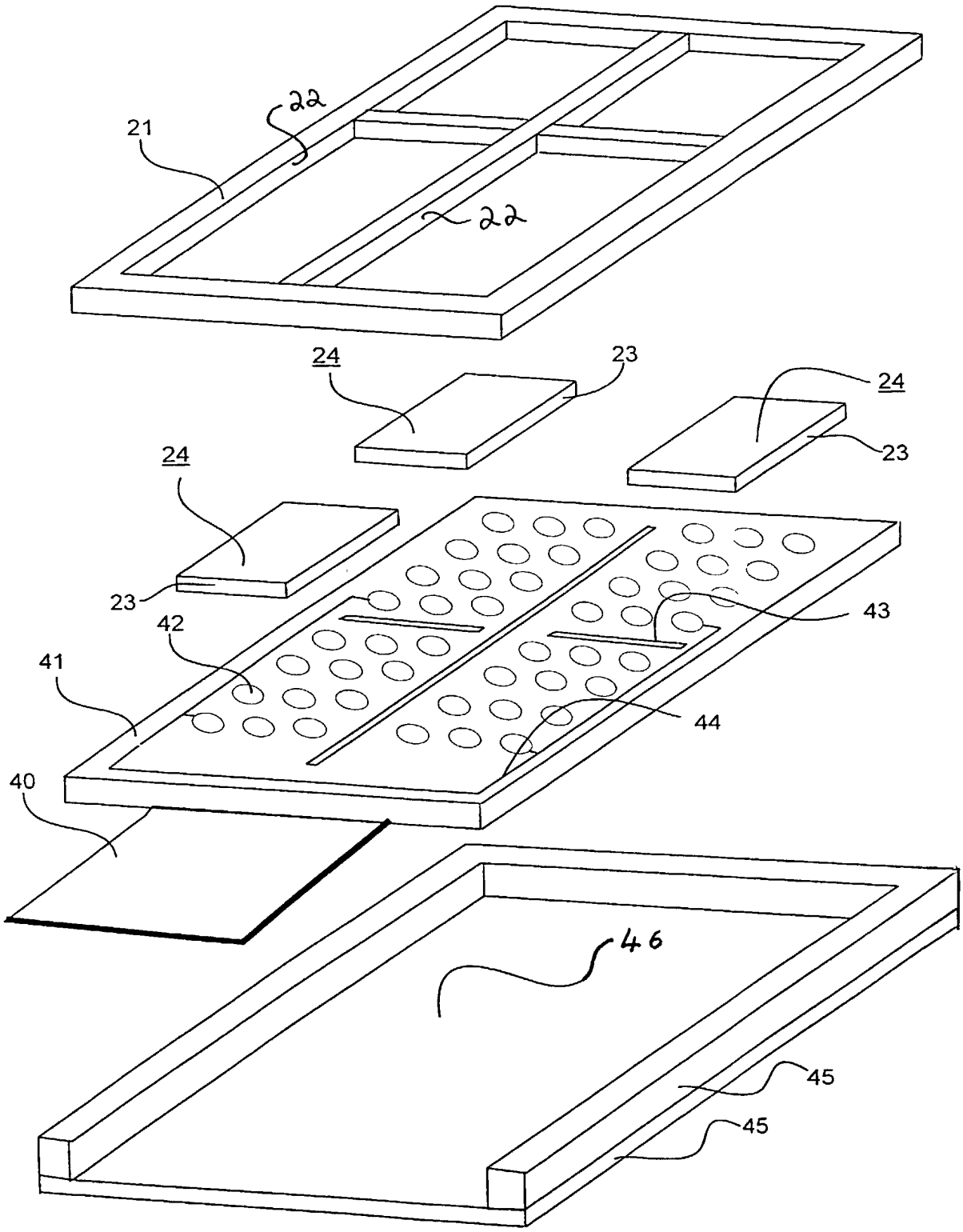


Figure 3

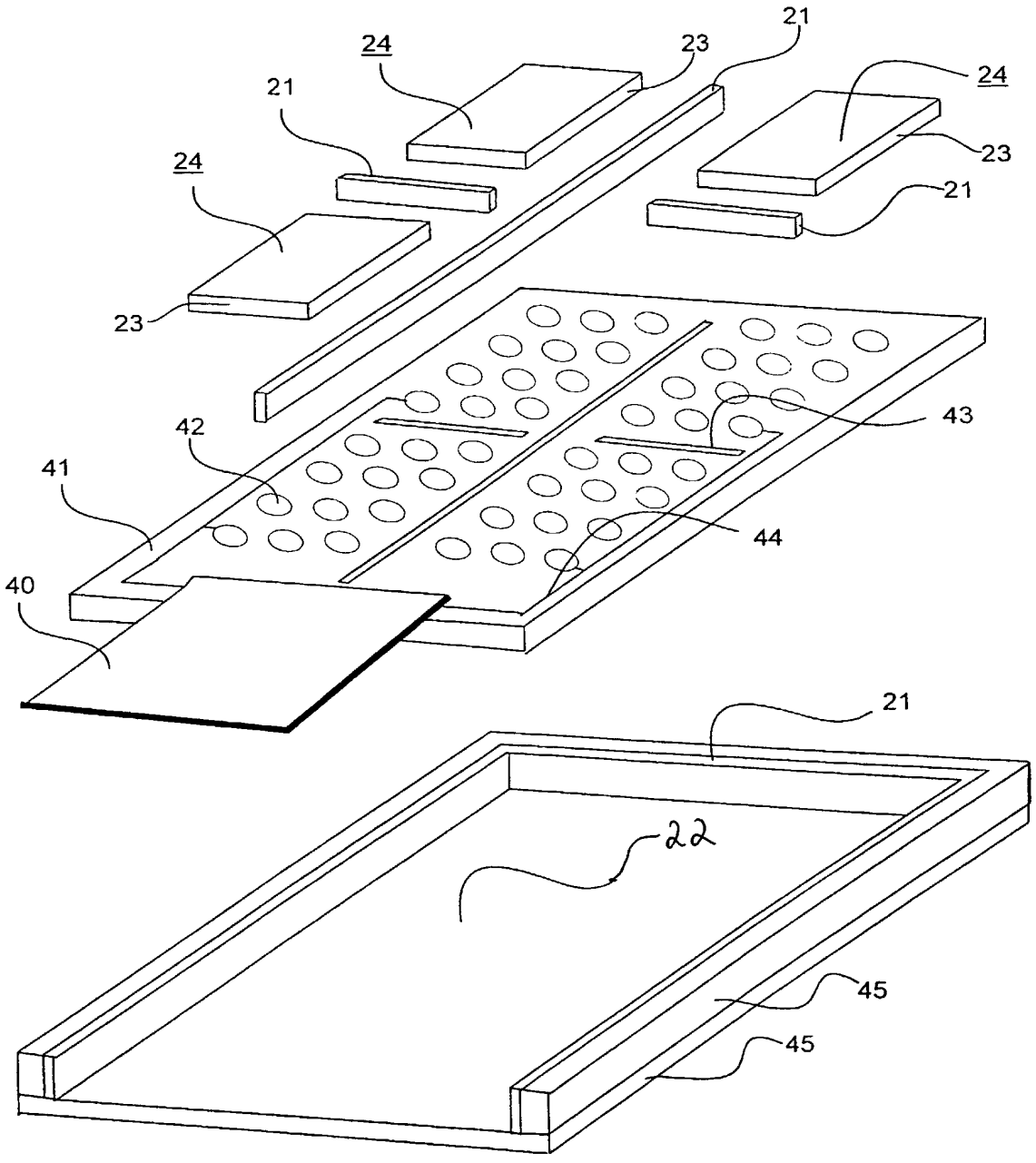


Figure 4

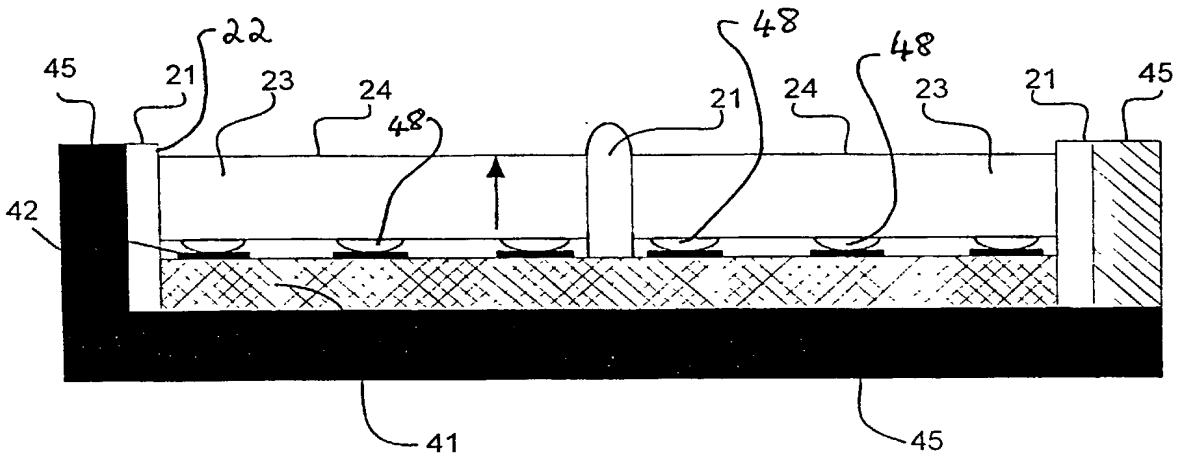


Figure 5

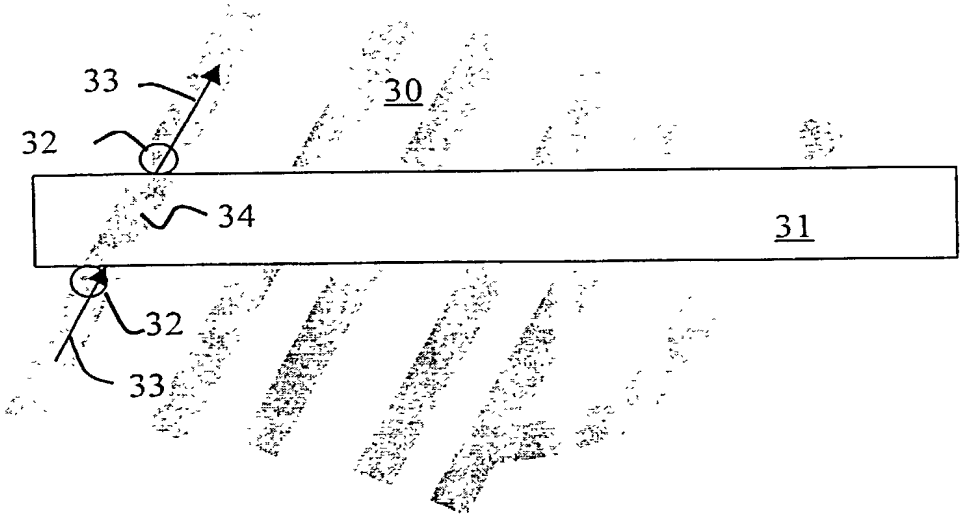


Figure 6

DECLARATION AND POWER OF ATTORNEY FOR UTILITY OR DESIGN PATENT APPLICATION (37 CFR 1.63)

As a below named inventor, I hereby declare that: My residence, mailing address, and citizenship are as stated below next to my name. I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled:

FINGERPRINT SENSING APPARATUS

the application of which
☐ is attached hereto

OR

☑ was filed on February 11, 2002 as United States Application Number or PCT International Application Number _____ (Confirmation No._____), and was amended on _____ (if applicable).

I hereby state that I have reviewed and understand the contents of the above identified application, including the claims, as amended by any amendment specifically referred to above.

I acknowledge the duty to disclose information which is material to patentability as defined in 37 CFR 1.56, including for continuation-in-part application(s), material information which became available between the filing date of the prior application and the national or PCT international filing date of the continuation-in-part application.

I hereby claim foreign priority under 35 U.S.C. 119(a)-(d) or (f), or 365(b) of any foreign application(s) for patent, inventor's or plant breeder's rights certificate(s), or 365(a) of any PCT international application(s) which designated at least one country other than the United States of America, listed below and have also identified below, by checking the box, any foreign application(s) for patent, inventor's or plant breeder's rights certificate(s), or any PCT international application(s) having a filing date before that of the application on which priority is claimed.

Prior Application Number(s)	Country	Filing Date	Priority Claimed Yes	Priority Claimed No
PCT/SG99/00082	SG	August 10, 1999	☑	☐

I hereby claim benefit under 35 United States Code §119(e) of any United States provisional application(s) listed below.

Application Number(s)	Filing Date

I hereby claim benefit under 35 United States Code §120 of any United States application(s) or §365(c) of any PCT International application(s) designating the United States, listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in a listed prior United States or PCT International application in the manner provided by the first paragraph of Title 35, United States Code, §112, I acknowledge my duty to disclose any information material to the patentability of this application as defined in 37 C.F.R. 1.56 which occurred between the filing date of the prior application and the national or PCT international filing date of this application:

Prior U.S. or International Application Number(s)	U.S. or International Filing Date	Status

I hereby appoint all attorneys of **SUGHRUE MION, PLLC** who are listed under the USPTO Customer Number shown below as my attorneys to prosecute this application and to transact all business in the United States Patent and Trademark Office connected therewith, recognizing that the specific attorneys listed under that Customer Number may be changed from time to time at the sole discretion of Sughrue Mion, PLLC, and request that all correspondence about the application be addressed to the address filed under the same USPTO Customer Number.

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PATENT TRADEMARK OFFICE

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under 18 U.S.C. 1001 and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

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